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Computer assisted functional (OEP) analysis

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Computer assisted functional (OEP) analysis

Abstract

This project consists of two parts. Part one is a computer program written in Microsoft Excel which calculates and completes OEP functional analysis. Part two, which is the body of the thesis, is a user's manual for the program. OEP analysis was designed for the practitioner to determine the most effective, easily tolerated lens prescription based on behavioral vision concepts. Appropriate management of a patient requires the practitioner to understand the purposes and processes of the analysis systems utilized for the case. This program is not designed to be a replacement for understanding functional analysis or as a "crutch". It is designed to aid those who already have a strong functional understanding of OEP analysis. The program does the calculation portion of OEP analysis, but it does not take into account the individual patient's needs or apply clinical wisdom that comes with practicing functional optometry. It is designed as a time saving tool to enhance patient care.

Degree Type

Dissertation

Degree Name

Master of Science in Vision Science

Committee Chair

Scott C. Cooper

Subject Categories

Optometry

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COMPUTER ASSISTED
FUNCTIONAL (OEP)
ANALYSIS

BY

MARK LEE

A thesis submitted to the faculty of the
College of Optometry
Pacific University
Forest Grove, Oregon
for the degree of
Doctor of Optometry
May, 2000

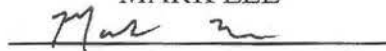
December 17, 1999

Adviser:
Scott C. Cooper, O.D., M.Ed., F.A.A.O.

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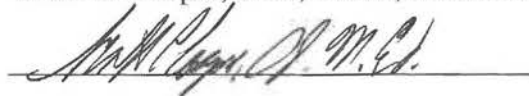
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ABSTRACT

This project consists of two parts. Part one is a computer program written in Microsoft Excel which calculates and completes OEP functional analysis. Part two, which is the body of the thesis, is a user's manual for the program. OEP analysis was designed for the practitioner to determine the most effective, easily tolerated lens prescription based on behavioral vision concepts. Appropriate management of a patient requires the practitioner to understand the purposes and processes of the analysis systems utilized for the case. This program is not designed to be a replacement for understanding functional analysis or as a "crutch". It is designed to aid those who already have a strong functional understanding of OEP analysis. The program does the calculation portion of OEP analysis, but it does not take into account the individual patient's needs or apply clinical wisdom that comes with practicing functional optometry. It is designed as a time saving tool to enhance patient care.

OEP Functional Analysis User's Manual

Foreword

OEP functional analysis was designed for the practitioner to determine the most effective, easily tolerated lens prescription based on behavioral vision concepts. The process was developed over 50 years ago. Appropriate management of a patient requires the practitioner to understand the purposes and processes of the analysis systems utilized for the case. Though the procedures have remained the same, our understanding of them has been expanded throughout the years. This program is not designed to be a replacement for understanding functional analysis or as a "crutch". It is designed to aid those who already have a strong functional understanding of OEP analysis. The program does the calculation portion of OEP analysis, but it does not take into account the individual patient's needs or apply clinical wisdom that comes with practicing functional optometry. It is designed as a time saving tool to enhance patient care.

Getting Started

In order to use the OEP Functional Analysis program you must have Microsoft Office 97 or higher on your computer with Excel and Microsoft Word. To begin start Microsoft Excel on your desktop and go to the **File** menu and click **Open**. From within the **Open** menu, go to where you saved the OEP program and open the file "OEPanalysis.xls". Now you are ready to get started.

Entering Data

Once the program is open, you will be presented with a data table:

Habitual:			#13b	
Test Lens:			#14a	
#3			#15a	
#13a			#14b	
#4			#15b	
#5			#16a	
#7			#16break	
#7a			recovery	
#8			#17a	
#9			#17break	
#10break			recovery	
recovery			#19	
#11break			#20	
recovery			#21	

Enter your findings in the space provided for each OEP examination finding. For typical patients with negligible anisometropic differences, sphere values for the right eye only are entered for spaces requiring a dioptric value. If cylinder values change through the examination sequence, then enter the spherical equivalent for all dioptric values.

When entering phoria values enter exo values as negative and eso values as positive. For example, 5 exo would be entered as “-5”. **Note:** For each value enter the gross lens value, not the net since the OEP analysis program will calculate nets automatically.

Example: If the #21 value is +2.50D over a #7a value of -3.00D then the lens value entered would be -0.50D. It is easiest to record the total lens value in the phoropter (the gross value) at the endpoint of a test.

When entering vergence findings simply enter the total amount of prism found to blur, break, and recovery. A vergence value will only be negative if the finding was a value within the opposite range (a BI value when testing BO ranges). If you do not find a lens value, (for example there was no blur value for the #16) enter an “x” in the blank. Note that values must be entered for all but the following in order for the program to work correctly: #3, #13a, #9, #16a, #17a, and the #19. Near some of the entries, you will see a little red triangle in the upper right hand corner. By holding the cursor over the triangle, different instructions will be given for making an entry for that test.

The 21 Point Examination

For data entry, we have used OEP numbers for each piece of the 21 points of a complete vision examination. For anyone not familiar with the OEP numbers here is a quick description of each.

Habitual: Enter the habitual Rx of the patient here.

Vergence Control Lens: The lens, which was used for near testing of the positive and negative relative convergence. The lens through which these tests are performed should be recorded for each examination. In line with OEP protocols, the selection of a near point control lens is dictated by several factors:

1. For a non-presbyopic hyperope, use the #7 not the #7a.
2. For a myope who has worn lenses use either the habitual near lens or the #7 whichever is the most plus.
3. If no lenses have been worn and the subjective indicates minus use plano.
4. For the presbyope (or any patient who can not resolve 20/20 at near), several options are available.
 - a. Minimum plus to 20/20.
 - b. 0.25 to 0.50 of plus over minimum plus to 20/20.
 - c. UN-fused cross cylinder gross power.
 - d. Fused cross cylinder gross power.

*Should case data have been obtained through lenses other than these, simply enter that lens value in the **Control Lens** blank.

#3 Habitual Lateral Phoria at Distance: This can be taken either with the patient wearing their habitual lenses behind the phoropter, or by placing their Rx in the phoropter. The target used should be a 20/20 letter or line, or the smallest letter that the patient can resolve at distance. With the patient's far PD in the phoropter, a Von Graefe lateral phoria is taken starting from base-in and decreasing until the patient declares alignment.^{1,3}

#13a Habitual Lateral Phoria at Nearpoint: Like with the #3, the patient either wears their near habitual lenses behind the phoropter or the power is placed in the phoropter. If the patient wears bifocals they can either raise the lenses so they are looking through the segment, or the add can be dialed in over their distance Rx. Full near illumination* needs to be provided with the patient's near PD in the phoropter. The target should be a single 20/20 vertical line or the smallest optotype that the patient can resolve. Von Graefe lateral phorias are performed.

#4 Distance Retinoscopy: Retinoscopy is not interpreted by the behavioral model as only an objective measure of refraction, therefore it differs somewhat from standard practice. Initially the procedure begins with both eyes set at the patient's habitual refraction. The patient views the smallest line they can read at distance while the practitioner adds spherical plus to the eye being tested until "against" motion is scoped in all meridians.^{1,3} Retinoscopy procedure is then applied to the eye until neutrality is achieved in all meridians. The point of initial neutrality found by reducing power from excessive plus is termed "high neutral".³ Once neutrality is achieved the working distance is removed from the gross retinoscopy value giving the net value, and the other eye is scoped using the same technique. Note that the patient fixates the distance target during the procedure without a fogging lens. This technique is utilized to help the clinician see how the patient performs in distance space. It is recommended to recheck the right eye after the left eye has been evaluated. If an adjustment is needed the suggestion is to continue alternating retinoscopic tests until high neutral is established.

Most contemporary examinations follow static retinoscopic procedures. These will often yield higher plus endpoints than the procedure just described. This, therefore, is a variable the practitioner must acknowledge when applying OEP analysis to a particular case.

#5 Nearpoint Retinoscopy: Near retinoscopy is performed upon completion of #4. The procedure begins by adding two diopters of plus sphere to both eyes over the #4 net value.³ The practitioner then positions themselves at a 20 inches or 50 cm working distance. The near PD is adjusted and both eyewells are opened to allow for binocular viewing. The patient is asked to read and pay strict attention to letters or numbers no larger than a 20/40 optotype near the retinoscope mirror. Full near illumination* is provided on the near target.³ The clinician scopes both eyes sequentially and notes the motion. With the plano setting, some amount of "against" is expected in all meridians (neutral if the patient is a complete presbyope). If "against" is noted plus is reduced by 0.25D simultaneously in both eyes until the first "high neutral" is reached. If one eye still shows against motion, additional -0.25 increments are applied until both eyes simultaneously show neutral and/or with motion for the first time. The amount of anisometropia found should be within a quarter of a diopter of that found for distance retinoscopy. If it is not, the distance retinoscopy should be rechecked.

#7 Basic Subjective Formula: The #7 can be reached a variety of ways but a common sequence is to obtain monocular best corrected visual acuities, perform a binocular balance, and then starting from a 20/40 blur reduce plus until the 20/20 line can

be read. The #7 implies that all of the 20/20 optotypes can be read or recognized. When best corrected acuities are less than 20/20, the subjective lens can represent a best visual acuity. The #7 represents the maximum plus sphere power that can be prescribed for distance wear, and serves as a control lens for other distance and nearpoint findings.^{1,3}

#7a Maximum Plus to Best Visual Acuity at Distance: This lens represents the maximum plus that yields best binocular visual acuity.^{1,3} This is achieved by starting at the subjective and reducing plus until best visual acuity is achieved. Care must be taken not to overminus the patient.

#8 Induced Lateral Phoria at Distance: The induced lateral phoria is the patient's Von Graefe lateral phoria taken through the basic subjective formula lens. The technique is the same as described for the habitual lateral phoria.

#9 True Adduction at Distance: While the patient views a 20/20 target (or the smallest letters they can resolve) binocularly at distance through the subjective formula lens, base-out prism is added equally to both eyes until the first recognizable blur is achieved. To demonstrate blur a quarter diopter of plus can be added, and the slight blur on the letters can be called to the patient's attention. This can then be used as a reference for the patient as what "noticeable blur" is.¹ Note that blur-out is not sought but the first recognizable blur instead. The total prism to first blur is recorded, or if no blur is seen, the value is recorded as "X" for the #9.

#10 Convergence at Distance: Continuing from the #9 value, base-out prism is added until the patient reports diplopia or experiences suppression. The value of prism to achieve diplopia is recorded as the #10 "break." A few more prism diopters are added to ensure diplopia and then the amount is decreased until the patient reports fusion. This amount of base-out prism is recorded as the "recovery", if the value is a base-in prism the "recovery" is recorded as a negative value.¹

#11 Divergence at Distance: This relative vergence test is performed like the #10, but base-in is added until diplopia or suppression is reported by the patient. Again, the "break" and "recovery" are recorded. No target blur should be recorded since the test is designed such that accommodation is relaxed completely.³ The only time the patient may report blur during the #11 would be if they are over-minused or if they are overly sensitive to prism distortion.

#13b Induced Lateral Phoria at Nearpoint: This value is achieved with the same technique as the habitual lateral phoria at near (#13a), but through the subjective formula lenses (#7). If the standard acuity target can not be read though the #7, as in a presbyope, plus sphere should be increased binocularly until the target can first be resolved, minimum plus to 20/20.^{1,3}

#14a Unfused Crossed Cylinder: The #14a evaluates spontaneous accommodation at near when vergence is suspended. The setup is a cross-grid target at 40cm with illumination* reduced to 2 foot candles on the target. The target is

dissociated vertically using enough prism such that there is no overlap. The patient is then asked to compare the darkness of the two grids. If they are unequal, usually a quarter diopter change in one eye will create equality. A crossed cylinder lens with minus cylinder axis 90° is then introduced and sufficient plus is added binocularly until the patient reports that the vertical lines of each grid are darkest. The patient is then asked to view each target separately and report which lines are darkest. If the vertical lines are reported as darker, they are asked to look at the other grid and report the darkest lines. As they look at the 2nd target, plus is reduced by 0.25D in the eye that is not being attended. This process is continued until the lines are reported as equal. The lens value to first equality is recorded as the #14a.^{1,3} If there is no equality, then the lens value for "last vertical" is recorded as the #14a.

#15a Lateral Phoria Through the Unfused Crossed Cylinder: For this test the setup is left exactly the same as with the #14a and the patient is asked to view one of the grids as a Von Graefe phoria is performed. Prism upon alignment is recorded as the #15a phoria. Caution must be taken NOT to instruct the patient to maintain clarity of the lower image. This would be impossible due to the presence of the crossed cylinder lens and goes against the functional purpose of this particular phoria measurement.

#14b Fused Crossed Cylinder: For the fused crossed cylinder the dissociating prism is removed (#14a lens powers are still in the phoropter) and the patient is asked if they see a single target. Once binocularity is achieved, most patients will report the vertical lines are darker. If they see the horizontal as darker enough plus must be added binocularly such that they perceive the vertical as darker. Plus power is then removed until each line is perceived as equally dark,^{1,3} or if no equality is seen to the point of the horizontal lines being darker. This total lens value is then recorded as the #14b.

#15b Lateral Phoria Through the Fused Crossed Cylinder: The gross lens value of the #14b is left in the phoropter while illumination is returned to standard and the crossed cylinder lens is removed. A lateral Von Graefe phoria is then taken using standard technique and controls.

#16a Positive Relative Convergence: With the appropriate near lens in place and full near illumination, the patient is asked to view a single line of the smallest optotype they can resolve at 16 inches (40cm). Base out prism is added slowly over both eyes until the patient reports blur out (the point they can no longer read any of the letters).^{1,3} The total prism values are recorded as the #16a. If no blur is reported, an "X" is recorded on the exam form.

#16b Positive Fusional Reserve: Continuing from the #16a value, base-out is added until the patient reports diplopia or suppression. This is recorded as the "break value". More prism is added to ensure diplopia and then reduced until the patient reports fusion of the diplopic images which is then recorded as the "recovery". Note that the recovery can be a negative value if it takes base-in prism to regain binocularity.

#17a Negative Relative Convergence: This test is performed like the #16a, but with base-in prism until the patient reports blur-out. If no blur is reported, an "X" should be recorded on the exam form.

#17b Negative Fusional Reserve: Continuing from the #17a value, base-in is added until the patient reports diplopia or suppression. This is recorded as the "break value". More prism is added to ensure diplopia and then reduced until the patient reports fusion of the diplopic images which is then recorded as the "recovery". Note that the recovery can be a negative value if it takes base-out prism to regain binocularity.

#19 Amplitude of Accommodation: This test requires the use of a .62M Jaeger paragraph moved to 13 inches (33 cm).^{1,3} With full illumination on the card the patient is asked to read the paragraph as -0.25 lenses are sequentially added before each eye until sustained blur is achieved. Sustained blur is blur that can not be cleared by the patient by either blinking or greater exertion. It does not necessarily represent full blur out.^{1,3} The gross lens that produced sustained blur is recorded as the #19 finding. If the paragraph can not be read, plus is added until the paragraph first becomes legible before initiation of the test.

#20 Positive Relative Accommodation: For this test a single line of Snellen 20/20 letters (or smallest resolvable letters) is placed at sixteen inches and is fully illuminated. Starting from the control lens with the patient reading the letters minus lenses are sequentially added in 0.25D increments before each eye. The patient continues to read the letters until no letters are resolvable. The sphere power at the loss of resolution is recorded as the gross #20 value.³ In cases where diplopia is achieved before blur-out, the sphere power where this occurs is recorded as the #20.

#21 Negative Relative Accommodation: This procedure must directly follow the #20. The setup remains the same and the lens power is returned to the power of the control lens. Again the patient reads the letters and plus is added in 0.25D increments until blur out occurs. This lens value is recorded as the #21 gross.

***Near illumination:** Full illumination is defined as approximately 18 foot candles (200 lux) and can be obtained by placing a 60-watt incandescent bulb in the light stand positioned 6-8 inches from the nearpoint card.

***Illumination for 14a and 14b** is achieved by reducing room illumination and directing the near lamp toward the ceiling or wall behind the patient.

OEP Analysis

Once the data has been entered into the table, go to the **File** menu and select **Print**. Results of OEP functional analysis will be printed on a single page for your analysis.

The top section will appear as:

Patient:	The patient's name will appear here.
Case Type:	The case type will appear in this area.
Degeneration:	The amount of degeneration of the case will be displayed here.
MSDA:	Displayed here will be the maximum spherical dioptric acceptance.
Mandate:	The OEP mandate will be printed here.
Embeddedness:	The degree of embeddedness will occur here.
Recommended Distant Rx:	Up to three recommended distant Rx's will appear here.
Recommended Near Rx:	Up to three recommended near Rx's will appear here.
Recommendation:	OEP functional analysis recommendations will appear here.

Case Type

Based on the informative sequence (covered later), OEP analysis places the patient into one of four different case "Types". Data used for the case typing come from the #'s 5, 9, 10, 11, 16b, 17b and sometimes 14a/15a findings. In many ways, the case type is the "diagnosis" in OEP analysis. There are four possible case types in OEP functional analysis.

Type A: This is a rare case type that was designed to pick up "toxic" problems. These are treated and present like a B2 case, but be aware that a systemic problem may exist and further testing is indicated.¹ Be aware that these patients often present with an esophoria, low base-in ranges at near and far, and an accommodative system that is overactive.

Type B1: The B1 case type represents a visual system that reacts "normally" under sustained near visual activity. With excessive exposure to these activities, the pattern of visual functions will make progressively compromising adaptations (degenerate). It is characterized by a low 16b finding which is considered to be an active attempt to avoid the overconvergence that tends to occur with sustained near tasks.³ OEP classifies the B1 case type as that of relative accommodative insufficiency.³ This is considered to be the adaptive cycle of a "normal" system and relates well to current biomechanical models of accommodation and vergence interactions. These patients resemble convergence insufficient patients and often fall under this diagnosis by other analysis. One important note to remember is that initially during early stages of the B1 progression the patient may measure esophoric.

Another theory about these cases is that accommodation free of convergence can not maintain a near posture, and that a shift is made such that the patient comes to rely on a convergence-accommodative component to sustain a near posture.³

The most common complaints of a B1 patient after sustained near work are: ocular and bodily fatigue, short attention spans, headaches, periodic blur, asthenopia, lack of comprehension, skipping words, losing place while reading, slow reading, and a tendency to avoid reading.³ Objective findings of a B1 case often include: exophoria higher than norms, ductions restricted in the base-out direction (particularly at nearpoint), base-in ranges relatively increased, a decreased +/- 2.00D binocular flipper (below 16-18

cycles), a binocular positive relative accommodation (PRA) larger than a monocular PRA, and a gradient AC/A ratio less than 3:1.³

Type B2: Like the B1 case the B2 case also degenerates under the stresses of sustained near visual activity. It is characterized by a low 17b finding.^{1,3} Unlike the B1 case, the patient is unable to inhibit overconvergence either from an exaggerated esophoric tendency or from excessive nearpoint activity. In turn, accommodative adaptations are pronounced along with the overconvergence (poor divergence) tendencies. OEP classifies this case type as having relative accommodative dominance.³ In these cases accommodation does not lose its ability to maintain a sustained nearpoint posture. B2 cases often are considered to represent an intensified or exaggerated accommodative interference problem. These cases often resemble and fall under the convergence excess diagnosis by other analysis.

Subjective findings of a B2 include: the crowding of reading material well inside normal reading postures, avoid reading for extended periods, experience asthenopia associated with near tasks, and complain of distance blur upon near-to-far fixation changes.³ Objectively these patients demonstrate phorias close to orthophoria or into esophoria (especially at nearpoint), ductions that are extended in the base-out direction but reduced in the base-in direction, binocular PRA that is less than the monocular PRA, and a gradient AC/A that is greater than 4:1.³

Type C: The C type case is considered a “non-characteristic” response to nearpoint activity and represents a true convergence problem. To classify a case as a “C” type, all accommodative data must show expected or above expected performance. OEP classifies these patient as having interactive dysfunction.³ These patients present as having little or no interaction between accommodation and convergence. For these patients the accommodative and convergence systems are essentially independent of one another.³ These patients over-accommodate yet under-converge.

Subjectively the C type patient avoids near visual tasks with a passion, reading is not enjoyable and nearpoint activities are often neglected.³ Like the B1 case type they report ocular and body fatigue, short attention spans, headaches, periodic blur, asthenopia, lack of comprehension, skipping of words, losing place on the page, and slow reading.³ Because they tend to avoid reading so avidly often the intensity of these symptoms are not as great as with the B1 case. Clinical objective findings will include high exophoric postures, large breaks with low recoveries for all ductions, a very low AC/A, and suppression is not uncommon especially at nearpoint.³

Degeneration (Deterioration of B-type Cases)

With prolonged and/or repeated nearpoint stress without adequate recovery time, adaptation is required of the visual system to block the resulting over-convergence. The amount of nearpoint stress varies from individual to individual depending on degree of motivation, time spent at near, and the readiness of the individual to perform the nearpoint task.^{1,3} With the continuation of nearpoint stress adaptations are made to make the task more efficient. As adaptation occurs certain findings change, and these changes define the general case type.

Levels of adaptive change depend on the patient's near requirements and the inherent ability to deal with them. They may not need to degenerate very far, but if demands increase, they may progress further. OEP represents the level of degeneration as 1-7. The basic level of "B" type degeneration is represented as "1" and the highest level of degeneration is represented as a "7". The findings indicating the greatest deterioration are used when defining the level of case degeneration.³ Note that in this OEP case analysis program there is an indicator that lists the other levels of degeneration whose criteria are met to the side of the case's own degeneration. If the case was listed as a level 7 degeneration, but the only other criteria that was met was a level 1, then it might be assumed that there was an aberrant finding (based on the rest of the case).

Level 1: The basic level of B1 or B2. All analyzed relationships are as expected for good visual performance.

Level 2: Monocular accommodative posture shows less plus acceptance (14a and 14b equal).

Level 3: The loss of monocular plus acceptance as defined by the #14a is complete. The patient minus projects at near.

Level 4: The NRA/PRA and NRV/PRV comparisons do not show an ideal pattern.

Level 5: Accommodative amplitude is reduced or "inhibited".

Level 6: The patient can no longer converge as well as diverge to prism relative to a distant target.

Level 7: The patient cannot release accommodation appropriately when offered full plus for the working distance during a cognitive task on a resolvable target.

MSDA

Maximum spherical dioptric acceptance (MSDA) represents the lens value that is the maximum plus the patient can wear with comfort at the nearpoint.³ The MSDA is the lens value from which reductions in plus will be made as indicated by the case type and level of degeneration. The ultimate purpose of this value is to ensure that the practitioner knows the amount of plus easily worn by the patient. This helps avoid non-acceptance of an overly aggressive prescription, or indicates the need to discuss potential adaptive difficulties with the patient when the MSDA is exceeded. The MSDA can never be more plus than the highest of the #14 net values or the #7.³ It can not be less plus than the #7a for a myope or less than plano for the hyperope or emmetrope.³

In order to ensure patient comfort, the equilibrium pattern (the pattern of high/low relationships of the NRA/PRA and the NRV blur/PRV blur) is compared between the patient's habitual near lens and proposed near lens (see Equilibrium Pattern section of the manual). If the equilibrium pattern is reversed or changed, the lens is deemed unacceptable.^{1,3} The MSDA is determined by examining the equilibrium patterns of the most plus value of the #14a net, #14b net or #7. If this lens value is not rejected (based

on the equilibrium pattern), the MSDA is found. If this most plus value is rejected, exploration of lesser plus lenses takes place until the most plus that doesn't disrupt the habitual pattern is found.

A clinician may want to prescribe more plus than the MSDA. This is allowed when disruption is desirable (therapy or to try to break a myopic pattern), or when the increase in plus results in a more ideal pairing of vergence and accommodation. Normal pairing is considered to be the 16a-21 both high and the 17a-20 both low pairing (see Informative Sequence portion of manual).³ Regardless, patient education regarding lens adaptation is indicated.

Mandate

Based on the case type and level of degeneration, OEP makes a mandate concerning the lens power to prescribe at near and far. There are only three different mandates made by OEP analysis: full plus at far and near, cut plus at far and near, and cut plus at far with full plus at near. All cuts in plus are made relative to the #7 for the distance lens consideration, and the MSDA for near lens consideration.^{1,3} These cuts are made in 0.25D increments with a maximum cut of 0.75D. Accurate case typing, besides giving diagnostic insights, provides the key to successful lens application. OEP makes the following recommendations or mandates for successful lens prescriptions:

A case type: Treat the same as a B2 case type.

B1 degeneration 1-5: Prescribe full plus at far and near.

B1 degeneration 6-7: Cut plus at far and near.

B2 degeneration 1-5: Cut plus at far, full plus at near.

B2 degeneration 6-7: Cut plus at far and near.

C case type: Cut plus at far and near. The C-type cases are not classified by degeneration since poor convergence activation is the sole problem. They have also been shown to respond poorly to plus therapy so the amount of plus is cut both far and near.³

Embeddedness

This allows us to look at how long this problem has been stable (how engrained is it), or find if this visual system is reasonably flexible, alterable or changeable. The level of embeddedness will be displayed as either being "embedded", "non-embedded", or "indefinite". This will be used to indicate the level of intervention needed to yield improvement. When certain visual patterns become engrained, patterns of analytical findings change in a way as to define an embedded syndrome. Until such a pattern is engrained the system remains pliant and is considered non-embedded or disorganized. There are 7 different syndrome findings (see Embedded versus Non-embedded syndrome section of manual for criteria) for each embedded and non-embedded syndromes, a case which demonstrates 5 of the 7 characteristics is labeled as "embedded" or "non-embedded". Cases where less than five criteria are met are labeled as "indefinite" allowing a practitioner a greater freedom of therapy options.

Embedded cases are less flexible and less amenable to improvement than non-embedded. These patients also tend to have fewer symptoms. Usually it is best to make cuts in plus at both far and near.² If with-the-rule cylinder is present it should probably be prescribed to its maximum extent.² Improvement is much harder to initiate in embedded cases and the case must first be dis-embedded through therapy. An embedded case represents more time and effort if changes are to be made through therapy. Additionally, the patient may go through a period of increased symptoms as the improvement takes them through a non-embedded pattern.

Non-embedded cases are much more flexible and are more likely to achieve improvement with minimal intervention. These cases tend to be symptomatic, unlike most embedded cases. Lenses alone may bring about the desired improvements. Often more plus can be prescribed than what is suggested by fitting mandates at both far and near, with an expected improvement in function over time. With non-embedded cases, there is greater freedom in reducing or eliminating with-the-rule cylinder from the prescription.² Re-adaptation to a lens prescription can be expected in the absence of therapy, unlike an embedded case where a clinician will have a much harder time utilizing lens-only treatments. Vision therapy often results in desirable outcomes much quicker than in an embedded case.² Since the visual system is already in a state of flux, the non-embedded state is the most open to any kind of prescriptive change whether that be by lenses or therapy.

Recommended Distance Rx

Based on the mandate, the recommended distance Rx is provided. All cuts in plus are made relative to the #7 and the maximum cut in plus can be no greater than the #7a in myopes or below plano in a hyperope. Up to three lens powers will be listed, and any one of them would be an acceptable lens in the distance for the patient. Final lens selection should be based on the case presentation, treatment goals of the patient and the examiner, the embeddedness of the case, etc.

Recommended Near Rx

Based on the mandate the recommended near Rx is provided. All cuts in plus are made relative to the MSDA. Up to three lenses will be listed as being recommended for near use. Any one of them is acceptable for use with the patient. Remember that these are simply recommendations and that different lenses could be prescribed but patient adaptation would more than likely need to take place before they achieved comfort with the lens. Final lens selection should be based on the case presentation, treatment goals of the patient and the examiner, the embeddedness of the case, etc.

Recommendation

This gives the practitioner a final recommendation about the best course of action for the patient. When a patient is not notably degenerated and found to be non-embedded, satisfactory results can be realized with lens prescription alone. However, lens therapy is often inadequate or inefficient to reverse deterioration and provide

favorable improvement. Based on case type and degeneration OEP analysis will make one of the following recommendations regarding the use of vision therapy.

B1 degeneration 1-3: Lenses alone, therapy alone, could mix.

B1 degeneration 4,5: Lenses and therapy.

B1 degeneration 6,7: Therapy alone (lenses for clarity needs).

B2 degeneration 1-5: Lenses alone, could mix in therapy depending upon goals.

B2 degeneration 6,7: Lenses and therapy.

OEP Nets and Checking

Below the first section of the printout are the important calculation tables that were made during OEP analysis.

Test	Result	Net	Check		
#3	-1		H		
#13a	-12		H		
#4	-3.25		L		
#5	-2	-3.13	H		
#7	-2.75				
#7a	-3.25				
#8	-2		H		
#9	9		N		
#10break	10		L		
recovery	2		L	#10	L
#11break	18		H	#11	H
recovery	13		H		
#13b	-14		H		
#14a	-2	-3.50	L		
#15a	-12		H		
#14b	-2.25	-3.50	L		
#15b	-15		H		
#16a	8		L		
#16break	12		L	#16b	L
recovery	-4		L	#17b	H
#17a	22		H		
#17break	36		H		
recovery	24		L		
#19	-4	3.75	L		
#20	-3.75	1	N		
#21	-1.75	1	N		

OEP net values are calculated not only from the sphere “gross value” but also incorporate a “Lag”* factor when calculating the net values of accommodative posture tests. This is designed to account for the accommodation and vergence interactions when posture data is applied to a normal viewing situation. For each value in the 21 point

sequence the result is compared “checked” to an expected value for that test. The OEP expected values are as follows:

*This is NOT a lag by physiological optics definition. Unfortunately, this is the terminology originally used to describe the handling of accommodative posture test data. So, although “lag” will continue to be used, keep the concept of these particular net values separate from net calculations, which are more commonplace today.

Table of Expected Values:

#3:	0.50 exo
#13a	6 exo
#5 net:	#4 or more plus
#8:	0.50 exo
#9:	7 to 9
#10:	19/10
#11:	9/5
#13b:	6 exo
#16a:	15
#16b:	21/15
#17a:	14
#17b:	22/18
#19net:	5.00
#20net:	-2.25 to -2.50
#21net:	+1.75 to +2.00

Based on each of these expected values, the findings are checked as high, low, or neutral. Many of the checks are a simple comparison but some are based on calculated values of expecteds depending on other findings for the patient. Note that for analysis procedures, the distance reference is the #7, not the #7a that would offer the greatest clarity. This is a convention to keep the analysis process as simple as possible for both distance and near. For more information on calculation formulas, refer to one of the references.

Informative Sequence

Below the table of nets and checking the informative sequence is displayed.

Inform. Sequence	#7	Case Typing	Near Plus Acceptance	Equilibrium Findings	Accommodative Amplitude
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The first value in the informative sequence represents the #7 value. The second grouping of values represents the case typing. Each case type is classically defined as the following:^{1,3}

Type A: $\frac{4-11-13b-17b}{5}$
Type B1: $\frac{9-11-16b}{5}$

Type B2: $\frac{5}{9-11-17b}$
 Type C: $\frac{15a}{5-10-16b}$

“Case typing” is used to evaluate near plus acceptance by comparing the pattern of the #14a to #15a nets. A pattern of 15a over 14a indicates a pattern of decreased plus acceptance at near and a degeneration level of at least 3.

The next set of findings shows the equilibrium finding or pattern for the patient (through the near control lens). This value becomes important in determining the MSDA, level of degeneration, and for making a clinical judgement as to whether the pairing is ideal (An ideal pairing is 16a-21 higher than 17a-20).

The final sequence will show whether the #19 is high or low indicating if the accommodative amplitude is above or below expected. In this spreadsheet program, if no number is listed, either high or low in the sequence, it indicates that the finding had a neutral value.

Equilibrium Pattern

On the printout, a table will be presented below the informative sequence that shows the equilibrium pattern of various lens values from the examination.

Lens	value	16a	17a	#20	#21	equilibrium pattern	
Habitual	-3.5	24	12	-5.75	3.5	16a/17a	20/21
Control L	-3.5	24	12	-5.75	3.5	16a/17a	20/21
14a net	-1.08	14.33	21.67	-8.17	1.08	17a/16a	20/21
14b net	-2.92	21.67	14.33	-6.33	2.92	16a/17a	20/21
7a	-3.5	24	12	-5.75	3.5	16a/17a	20/21
#7	-3	22	14	-6.25	3	16a/17a	20/21

The values for the #16a, #17a are estimated using an “ideal” AC/A of 4:1. If there is a change in the pairing in the equilibrium pattern that is different from the patients habitual near lenses pattern, the lens is deemed unacceptable for near wear(unless there is a therapeutic need to disorganize the patients pattern). In this example you can see that the #14a net value is too great in plus since it changes the habitual pattern from 16a/17a to 17a/16a. By estimating comparative equilibrium patterns OEP analysis is able to estimate the maximum plus accepted by the patient.

Embedded versus Non-Embedded Syndrome

The last chart displayed on the printout displays the criteria for embedded vs. non-embedded syndromes, and whether or not the patient meets the criteria for each.

<u>Embedded Syndrome</u>	1 if "yes"	<u>Non-Embedded</u>	1 if "yes"
#4 > or equal to #7		#4 lower in plus than #7	1
#9 close to or equal to expected (7-9) (so has a value of 6-9)	1	#9 excessively low, except in myopia, when #9 will be high	
#10 break low but recovery above or equal to expected	?	#10 recovery low	?
#11 break and recovery up; recovery greater than or equal to expected	?	#11 break low, and recovery excessively low	?
#14b net > or equal to #14a net		#14b net lower than #14a net	1
In B1 case, #16b break low, with recovery > or = to expected. In B2 case, #17b break low, with recovery greater than or equal to expected	?	In B1 case, #16b recovery excessively low; in B2 case, #17b recovery excessively low	?
#19 and #20 are not both low, one high and one low	?	#19 and #20 both low	?
Sums	1		2

In this example the patient is neither embedded or non-embedded, therefore the case is labeled as "indefinite". The question marks indicate that criteria for embedded or non-embedded were not met exactly. This indicates that these may need to be looked at critically and a clinical judgement made as to whether the patient is embedded or non-embedded by looking at which findings most closely meet the criteria. One clinical approach is to consider anything that is not embedded as non-embedded, therefore the identifier of "indefinite" would never be applied.

Conclusion

Hopefully this program makes using OEP functional analysis more efficient so that the busy practitioner can take advantage of the insights that behavioral optometry has to offer.

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